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GUIDELINES FOR DETECTION SURVEYS OF FOREST PESTS IN THE NORTHERN REGION

By

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USDA Forest Service
State and Private Forestry
Northern Region Missoula, Montana

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INTRODUCTION

The Forest Service is responsible for leadership and cooperation in field surveillance and detection surveys on about 35 million acres of forested land within the confines of the Northern Region. This duty has been assigned to Forest Insect and Disease Management (FIDM), State and Private Forestry. Basic survey policy is explained in the Forest Service Manual: Field surveillance (5221); Detection (5222); and Reporting (5222.31), (FSH 3090.11).

FIELD SURVEILLANCE

Field personnel of all land management agencies are trained and encouraged to detect and report abnormal forest conditions, insect, disease, and animal damage to FIDM. This early detection of pest damage could, and has, alerted us to potential outbreaks.

Training sessions in recognition of pests and their damage are conducted each spring and summer for Forest Service personnel. Additional training sessions are given to other Federal, State, and private agencies when requested.

Instructions for collecting, shipping, and reporting pest damage are stressed at these sessions, and kits to accomplish this are provided. All damage or pests are identified and reports answered promptly by FIDM specialists and remedial action initiated when needed.

GROUND DETECTION SURVEYS

Detection surveys are "scheduled systematic inspections of forest land by trained personnel." Almost all detection surveys in this Region are made by aerial observations.

We have used ground surveys to follow the spread of larch casebearer since it was discovered in 1957, and later to detect introduced and native parasites of it. These were roadside surveys.

With the advent of pheromone-baited sticky traps, we can systematically cover an area with them to detect presence of many species of forest insects.

These traps were used successfully in 1975 and 1976 to determine distribution of the Douglas-fir tussock moth in Idaho and Montana and elm bark beetles in Montana in 1977.

Another detection method used is the establishment of permanent sampling plots. An example of this is to "beat" a certain number of fir trees per plot to dislodge such pests as Douglas-fir tussock moth or spruce budworm larvae feeding on their needles. They fall on ground sheets, and the number of larvae per unit is used to compare increases or decreases from year to year.

AERIAL DETECTION SURVEYS

The main aerial survey season in the Northern Region usually begins about mid-July and ends the first week in September. For several insects, surveys sometimes have to be made in June or late September. Almost all Federal lands are flown by FIDM personnel, but most State and private land in northern Idaho is surveyed by personnel from the Idaho Department of Public Lands, and a large portion of State and private land in Montana is covered by personnel from the Montana Department of Natural Resources and Conservation.

Each spring a schedule and a map showing areas to be surveyed, and by whom, are sent to all major landowners (table 2).

Equipment

Aircraft--Single- or twin-engined planes with high wings are needed for aerial surveys so the observer's view of ground vegetation is unobstructed. Planes used must be able to sustain flying speeds from 80 to 100 miles per hour for periods up to 5 hours without overheating or stalling. Enough climbing power is needed to fly up a drainage and turn with a load of three people.

A single-engined Cessna model 182 airplane is used for almost all detection surveys in the Northern Region. A Cessna model 180 or 185 is used if landings are required on rough strips because these aircraft have a tailwheel instead of tricycle gear (nosewheel). Cessna models 206 and 210 are single-engined, have more climbing power, and can be used to carry up to four people; they are more expensive.

Single-engined Cessna 180's and 182's have excellent safety records in the Northern Region, and Forest Service pilots feel they are as safe as twin-engined planes for our type of surveys. They are much less expensive to fly.

The twin-engined Aero-Commander is used for "show me" type trips because it can carry six passengers at faster speeds. Different models of helicopters are used for taking aerial photographs of damage, or mapping spots of damage more precisely.

Maps--Forest Service and other agencies' maps of 1/2-inch per mile scale, are generally used for sketch-mapping damaged areas. Geological survey maps, such as those for Glacier and Yellowstone National Parks, are about the same scale and have excellent detail. North Dakota county road maps, 1/2-inch per mile, are adequate for that State.

Maps are usually prefolded to about 9 by 11 inches. This size permits an 18- by 22-inch area to be held on the observer's lap when the map is partially opened. The observer is limited to this amount of space in the cockpit. Refolding maps in flight is awkward because of the lack of room; thus, the day's flight pattern should be well organized to keep folding to a minimum.

A No. 2 lead pencil is best for writing on these maps. Softer lead "smudges" easily and notations made during mapping may be undecipherable by the end of the flight. When bark beetle-killed trees are mixed in with areas of defoliation, it is best to mark the beetle kill in red pencil and defoliation with regular lead. Damage intensity is indicated by letters L, M, H, and VH to record light, medium, heavy, and very heavy damage. For file copies, blue, green, orange, and red are used to designate degree of damage. A rapidograph pen, No. 2 point, using India ink, or good grade felt tip pens are used for inking boundaries of infestations on file copies.

Methods

Briefing pilots--Before each survey season, a meeting is held to explain to contract and Forest Service pilots objectives, methods, and safety requirements of aerial detection surveys. Colored slides are shown of typical damage seen from the air. Charts showing flight patterns and elevations to be maintained over the forest canopy are used. The safety plan and pilot's responsibilities during flights are discussed in detail.

Timing insect and disease detection surveys--Optimum periods for detecting insect and disease damage symptoms during the flying season are listed in table 1. During a dry (drought) spring, current Ips beetle kill in ponderosa pine can become noticeable by July. However, for almost all other bark beetles it takes about a year after attack for the foliage to fade (these trees are called "faders" or "red tops"). Diseases such as root rots, stem rusts, mistletoes, and cankers do not kill trees in a year; damage symptoms progressively become more obvious. Damage by defoliators, needle diseases, and weather show up best during certain periods (table 1).

Pattern of flight--The terrain in Region 1 is very mountainous. Ranges are separated and divided by many major river drainages and creeks. Fly major river drainages so that the observer can always look out the right-hand window. Enter tributary creeks and leave them in this fashion also. This standard procedure enables the pilot to anticipate what is expected of him and the route to fly. Prearranged hand signals tell the pilot when to move the plane to the right, left, up, down, or turn. The observer can then concentrate on mapping without turning his head to talk.

Mapping procedures--Altitude during surveying varies with type of terrain, visibility, and damage. In general, altitude is about right when individual branches can be distinguished. In steep canyons, keep the ridgetops at eye level. Place the plane in a position that permits a view of all the trees from the creek bottom to ridgetop.

Table 1.--Timing aerial surveys to detect major pest damage in the Northern Region

Pest	Main hosts	Optimum survey period
Bruce spanworm	Aspen; other hardwoods	First of June
Larch casebearer	Western larch	First of June
Lophodermella concolor	Lodgepole pine; ponderosa pine	First of June
Cankerworms	Elms; other hardwoods	Mid June
Tent caterpillars	All hardwoods	Mid June
Ponderosa pine needle miner	Ponderosa pine	Mid June
Hypodermella laricis	Western larch	Mid June
Lophodermella arcuata	Lodgepole pine	June
Lophodermium pinastri	Ponderosa pine, lodgepole pine	June
Lecanostica acicola	Western white pine	June
Red belt	All species	June
Poria weirii	Most conifers	June-Sept.
Fomes annosus	Douglas-fir; ponderosa pine	June-Sept.
Armillaria mellea	All species	June-Sept.
Polyporus schweinitzii	All conifers	June-Sept.
Phomopsis canker	Douglas-fir; western larch	June-Sept.
Cytospora canker	All species	June-Sept.
Western gall rust	Lodgepole pine; ponderosa pine	June-Sept.
Comandra rust	Lodgepole pine; ponderosa pine	June-Sept.
Stalactiforme rust	Lodgepole pine; ponderosa pine	June-Sept.
Atropellis canker	Lodgepole pine; ponderosa pine	June-Sept.
White pine blister rust	Western white pine	June-Sept.
Dwarf mistletoe	Douglas-fir; western larch; lodgepole pine	June-Sept.
Air pollution	All trees	June-Sept.
Dothistroma pini	Ponderosa pine	First of July
Striped alder sawfly	Aspen; other hardwoods	Mid July
Western spruce budworm	All conifers	Mid July
Elytroderma	Ponderosa pine	Mid July
Douglas-fir tussock moth	All firs and spruce	Late July
Larch bud moth	Western larch	Late July
Pine tussock moth	Ponderosa pine	Late July
Pine sawflies	Lodgepole pine; ponderosa pine	Late July
Lodgepole needle miner	Lodgepole pine	Late July
Pine engraver beetles	Ponderosa pine; lodgepole pine	July-Sept.
Porcupine	Ponderosa pine; lodgepole pine; western larch	July-Sept.
Douglas-fir beetle	Douglas-fir	Late July-Sept.
Engelmann spruce beetle	Engelmann spruce	Late July-Sept.
Mountain pine beetle	Ponderosa pine; lodgepole pine; western white pine; limber pine; white bark pine	Late July-Sept.
Western pine beetle	Ponderosa pine	Late July-Sept.
Fir engraver	True firs	Late July-Sept.
Douglas-fir engraver beetle	Douglas-fir	Late July-Sept.
Western balsam bark beetle	Subalpine fir; grand fir; Engelmann spruce	Late July-Sept.
Western hemlock looper	Douglas-fir; true firs, western hemlock	First of Aug.
Black-headed budworm	All firs; western hemlock; spruce	First of Aug.
Larch sawfly	Western larch	First of Aug.
Sugar pine tortrix	Ponderosa pine; lodgepole pine; limber pine	First of Aug.
Western false hemlock looper	Douglas-fir; true firs	Mid Aug.
Pine butterfly	All pines	Mid Aug.
Pine needle-sheath miner	Ponderosa pine; lodgepole pine	Mid Aug.
Pine looper	Ponderosa pine	Late Aug.
Leaf beetles	All hardwoods	Late Aug.
Rhabdocline pseudotsugae	Douglas-fir	Late Aug.
Larch looper	Western larch	Mid Sept.
Variable oak leaf caterpillar	Oaks; other hardwoods	Mid Sept.

If the cause of damage is questionable, or if defoliation is very light, it is often necessary to fly about 500 feet above treetops with the flaps of the plane lowered to slow it down. This type of flight should not be maintained for long periods. Cone crops are sometimes so heavy that they have the appearance of insect damage.

For widespread damage, such as spruce budworm defoliation, the observer determines a height that enables him to see light defoliation (25 percent of the needles damaged), to keep oriented easily, and to observe as wide a range of area as possible.

Airspeeds of 90 to 100 mph are ideal for most surveying, but for some mapping, a speed of 80 mph is best. Observers become accustomed to mapping at given speeds and learn to keep oriented at those speeds. Faster or slower speeds may reduce their ability to stay oriented. Prolonged slow speeds should be avoided because engine overheating can result. An average of 50,000 acres per hour can be covered during a routine detection survey.

All forested areas in the Region are completely surveyed, and all symptoms of insect or disease damage are recorded. Groups of trees killed by bark beetles or other agents are pinpointed on maps. Next to each group location, tree species, apparent causal agent, and numbers of trees affected are recorded in abbreviated form. If groups are too numerous in a drainage, the perimeter of the area containing them is encircled, and the number of "faders" in the area is estimated.

Boundaries of defoliated stands are mapped and classified by degree of damage, i.e., light, moderate, heavy, and very heavy. Defoliation classes have the following appearances:

Light--Foliar damage ranges from barely visible to visible throughout the upper one-fourth of the tree. The infestation is not necessarily continuous. A few heavier spots may be present.

Moderate--Damage is clearly visible down to one-half the tree crown. It is not always continuous and there may be lighter and heavier spots.

Heavy--Foliar damage is visible to the bottom of the crown of most trees. There are but few breaks in the infestation and some dead trees may be present.

Very heavy--Degree of defoliation is the same as for heavy, but there are considerable numbers of dead trees.

These are arbitrary classes to describe defoliation as seen from the air. On the ground, actual defoliation in the various classes is about as follows: Light - 25-40 percent; Moderate - 35-60 percent; Heavy - 55-85 percent; and Very heavy - 80-100 percent.

If cause of defoliation is uncertain, place a question mark next to mapped damage, and record tree species involved, and appearance of damage (defoliation, bark beetles, or needle disease) next to question mark. The question mark indicates this area should be checked from the ground. To aid the checker, a more detailed description of the damage, timber type, and location should be recorded.

A legend is attached to the final maps that identifies causal agent by numbers on the map (table 2).

Aerial photography using colored and infrared film is becoming an important survey tool to estimate trees killed by bark beetles, root rots, some defoliators, and air pollution. Large-scale images are obtained with 35mm, 70mm, and 9- by 9-inch negatives.

Miscellaneous surveying information--Factors limiting the amount of flying time during a day include visibility, weather, and endurance.

Discolored foliage is hard to see on west-facing slopes before about 7:30 a.m. due to shadows. If there are forest fires in an area, it might be difficult to see damaged trees until the smoke dissipates. Overcast days seem to be the most favorable for detection surveys for the light is even and shadows are not prominent.

Winds, thunderstorms, and heavy rains can terminate surveying for the day. On hot days, turbulence caused by warm air rushing up from the valleys and spilling over ridgetops makes it dangerous to fly into narrow drainages. This condition usually starts about 2 p.m. Snowfalls can mask damage symptoms also.

Generally, take-off time is about 8 a.m. and mapping usually ends about 2 p.m. Some flying time is often spent going to or from the survey area. Pilot and observer usually become fatigued after about 5 hours of surveying. If there is an airstrip nearby, a lunch break should be taken around 10 or 11 a.m. Stretching the legs and eating relieve tension. The plane's tanks should be filled with gasoline during the break if possible. A Cessna 182 can usually fly about 5 hours at 100 mph on a tank of gas, but it is wise to have 1 hour extra margin of time. Airports with aviation gasoline are widespread in the Northern Rocky Mountain Region.

Reporting results--After each day's survey, data on the maps should be made more legible by inking infestation boundaries, coloring in degrees of damage, and inking descriptions. Legends containing numbers for the various pests, letters for host, and colors for degree of damage help to abbreviate the amount of writing on a map.

While surveying a National Forest, the survey maps should be shown to the staffman in the Supervisor's Office responsible for insect and disease problems. This is usually the silviculturist. Any major problems should be pointed out to him. He may want to make a copy of that section of a map. Show him areas that will be ground checked because the damage could not be identified from the air. He may already know the cause.

Table 2.--Key to numbers identifying forest insect and disease damage on aerial survey maps

BARK BEETLES

1. Douglas-fir beetle
2. Engelmann spruce beetle
3. Pine engraver
4. Mountain pine beetle (WP)
5. Mountain pine beetle (PP)
6. Mountain pine beetle (LPP)
7. Mountain pine beetle (WBP or Lim.)
8. Western pine beetle
9. Fir engraver
10. Douglas-fir engraver beetle
11. Western balsam bark beetle (SAF)
12. Unidentified bark beetle

DEFOLIATORS

20. Spruce budworm
21. Larch casebearer
22. Douglas-fir tussock moth
23. Pine butterfly
24. Black-headed budworm
25. Larch bud moth
26. Pine looper
27. Pine tortrix
28. Tent caterpillars
29. Leaf beetles
30. Larch sawfly
31. Hemlock looper
32. Larch looper
33. Western false hemlock looper
34. Pine needle-sheath miner
35. Pine sawflies
36. Pine tussock moth
37. Cankerworms
38. Variable oak leaf caterpillar
39. Unidentified defoliator

DISEASES

40. Poria weirii
41. Fomes annosus
42. Armillaria mellea
43. Polyporus schweinitzii
44. Phomopsis
45. Cytospora
46. Western gall rust
47. Comandra rust
48. Stalactiforme rust
49. Atropellis
50. White pine blister rust
51. Dwarf mistletoe
52. Elytroderma
53. Red belt
54. Sulphur dioxide
55. Fluoride
56. Lophodermium pinastri
57. Rhabdocline pseudotsugae
58. Lophodermella arcuata
59. Lecanostica acicola
60. Lophodermella concolor
61. Dothistroma pini
62. Hypodermella laricis
63. Root rot
64. Unidentified disease

OTHER

70. Fire
71. Porcupine
72. Windthrow

USE OF NUMBER SYSTEM

5(25) = First number indicates causal agent. Number in parenthesis is number of "red tops" (trees usually killed the previous year) in group or area.

Term and Color Designation Used to Indicate Degree of Damage

		Bark beetles (trees per section)	Defoliators (percent of defoliation)
Light	- Blue	10-25	25-40
Moderate	- Green	25-100	35-60
Heavy	- Orange	100-300	55-85
Very Heavy	- Red	300 plus	80-100

Survey maps are taken to the lab to trace the damage from them onto Mylar transparencies. These overlays are matched with chronoflex transparencies of each Forest and both transparencies are run through a diazoprinting machine which produces positive black and white copies showing pest damage on each Forest.

Any unidentified damage seen from the air is ground checked before maps are sent to land managers. All damage, including acres of defoliation and number of killed trees, is recorded on computer cards. A computer printout then shows the amount of damage caused by each agent, in each management unit, in each National Forest, and in each State.

Legends are included with copies of survey maps that are sent to Forest Supervisors' Offices, Ranger Districts, and other Federal, State, and private agencies. Included with the maps are a summary report of damage and any action to be taken and a computer printout sheet.

Table 3 lists all the Federal, State, and private agencies that aerial survey maps or detection reports are sent to each year.

All detection surveys are reported to the Washington Office by FIDM as part of the National State and Private Forestry Accomplishment Reporting System (FSH 3090.11).

AERIAL SURVEY SAFETY PLAN FOR REGION 1

Detection surveys require flying at low altitudes and slow speeds above the forest canopy, often in steep, narrow drainages. Most surveys are flown between 500 and 1,000 feet above the ground and at 85 to 110 miles per hour.

This hazardous flying requires strict safety precautions. The following safety procedures are followed in Region 1. Those in quotes are taken from the Forest Service Health and Safety Code and Forest Service Manual (5700 - Air Operations - 5716.1--6 and 7).

General Procedures

1. All flights will be ordered through the dispatcher at the Aerial Fire Depot in Missoula. He will fill out a form 5700-8 with the following information:

   a. List of passengers
   b. Destination
   c. Purpose of flight
   d. Dates of flights
   e. Type of plane needed
   f. Benefiting organization and project funding number

2. "The pilot in command shall be responsible for the safety of the aircraft, occupants, and cargo. He has complete authority to postpone,

Table 3.--Accomplishment dates of detection surveys and reports to Federal, State, and private agencies in R-1

Agency	Aerial survey schedule	Aerial survey	Ground check	Maps	Report	Misc.
			FEDERAL			
FOREST SERVICE						
Beaverhead NF						
Bitterroot NF						
Clearwater NF						
Custer NF						
Deerlodge NF						
Flathead NF						
Gallatin NF						
Helena NF						
Kootenai NF						
Idaho Panhandle NF's						
Lewis & Clark NF						
Lolo NF						
Nezperce NF						
Other						
BLM						
Billings Office						
Boise Office						
Butte Office						
Coeur d'Alene Office						
Lewiston Office						
Missoula Office						
Miles City Office						
Other						
BIA						
Montana						
Billings Office						
Blackfeet IR						
Northern Cheyenne IR						
Crow IR						
Flathead IR						
Fort Belknap IR						
Rocky Boys IR						

Table 3 --Accomplishment dates of detection surveys and reports to Federal, State, and private agencies in R-1 (con.)

Agency	Aerial survey schedule	Aerial survey	Ground check	Maps	Report	Misc.
			FEDERAL (con.)			
BIA (con.)						
Northern Idaho						
Coeur d'Alene IR						
Nezperce IR						
Other						
North Dakota						
Fort Berthold IR						
Fort Totten IR						
Turtle Mountain IR						
Other						
OTHER FEDERAL						
National Bison Range						
Corps of Engr. (Orofino)						
Glacier NP						
Yellowstone NP						
SCS (ND)						
Other						
			STATE			
Idaho Dept. Lands						
Montana (Helena)						
Montana Forestry						
ND State Forester						
ND Ent. (Fargo)						
Other						
Other						
			PRIVATE			
BN (Missoula)						
Champion Timber						
Diamond International						
Pack River						
Potlatch						
St. Regis						
Other						

change, or cancel his flight when he believes existing or impending conditions make it unsafe."

3. "The responsible Forest Officer shall cancel or terminate operations when, in his opinion, conditions make air operations unusually hazardous or when the pilot does not adhere to essential precautionary measures."

4. "All cargo shall be securely fastened in place." When possible, remove all luggage or unnecessary equipment before making surveys. This will lessen weight and prevent it from shifting or breaking loose during rough air.

5. "Pilots are limited to the following flight hours:

a. Seven hours per day for the first six days

b. After six consecutive flight days, a full day's rest is required."

6. To reduce weight, and increase climbing power during emergency situations, it is advisable to operate with only pilot and one observer in Cessna models 180 to 210. During training flights, another observer can be carried. There never should be more than three persons in the above Cessnas while surveying. If more than two observers are going on a survey flight, a twin-engined airplane such as an Aero-Commander should be used. Parachutes are not worn or placed in a plane (see Forest Service Health and Safety Code 2.25-3b). The extra weight of parachutes is a hazard if full power is needed.

7. Cooperators or land managers should not be encouraged to ride along on routine survey flights because of the extra weight and distraction to the observer. A special flight should be planned to show them damaged areas.

8. Seat belts will be worn at all times while plane is in motion. Shoulder harnesses for front seats shall be worn during takeoff and landing, and when flying at 500 feet.

9. The pilot is responsible for keeping the windshield and side windows clean for clear visibility.

10. Detection surveys are usually flown from 8 a.m. to 2:30 p.m. during summer months and average about 5-1/2 hours' flight time per day:

a. A break should be taken about 11 a.m. if there is an airport near by. Pilot and observer should eat lunch and have gas tanks filled. This break should not be prolonged because "smooth" air is at a premium in the morning.

b. The air often becomes turbulent after 2 p.m., and flights into narrow drainages should not be made if this occurs.

c. Flights should not be made when clouds obscure ridgetops.

11. Smoking should not be permitted if it causes discomfort to others.

Flight Plans, Radios, and Position Checks

1. A safety plan, methods of surveying and a map showing areas to be flown should be given to each Forest Air Operations Officer and Regional Dispatcher. Any schedule changes should be reported to them.

2. "Flight plans for all missions shall be filed." For direct city-to-city flights, flight plans can be filed and closed with FAA. For survey flights, flight plan will be given to nearest Forest Service Regional net station upon takeoff. Pilot states takeoff time and estimated time of arrival at a chosen airport.

3. "The flight plan must be closed upon completion of the day's flying with the nearest Regional air net station. The station receiving the closeout must inform the Forest receiving the last position report."

4. "Survey planes will be equipped with both Regional and Forest net radios." Forest Insect and Disease Management has four multichannel portable radios, which as a group, cover all Forests in the Region. Pilots will check all radios before leaving the ground to assure proper operation.

5. While in flight, the pilot will make periodic position reports and give direction of travel to a Regional or Forest net station. These reports are required at different intervals depending on the Forest being flown. Check-in times for each Forest are listed below:

Beaverhead - 15 minutes	Idaho Panhandle - 30 minutes
Bitterroot - 15 minutes	Kootenai - 30 minutes
Clearwater - 15 minutes	Lewis & Clark - 20 minutes
Custer - 15 minutes	Lolo - 15 minutes
Deerlodge - 15 minutes	Nezperce - 20 minutes
Flathead - 15 minutes	
Gallatin - 30 minutes	
Helena - 20 minutes or will work out procedure	

Sometimes, when flying low in deep drainages or entering a 'no communication area,' it is impossible to make contact at the proper time. The observer should be familiar with where these areas are (figure 1). If he is not, he should have the pilot ask the Forest dispatcher if there are 'no communication areas' in the day's flight path. If there are, and before entering them, the pilot will advise the station of approximate duration the plane will be out of communication; this cannot exceed 2 hours.

6. If radio communication breaks down and a position report cannot be made, the observer and pilot should fly to the nearest airport, and telephone the Forest dispatcher to report what happened.

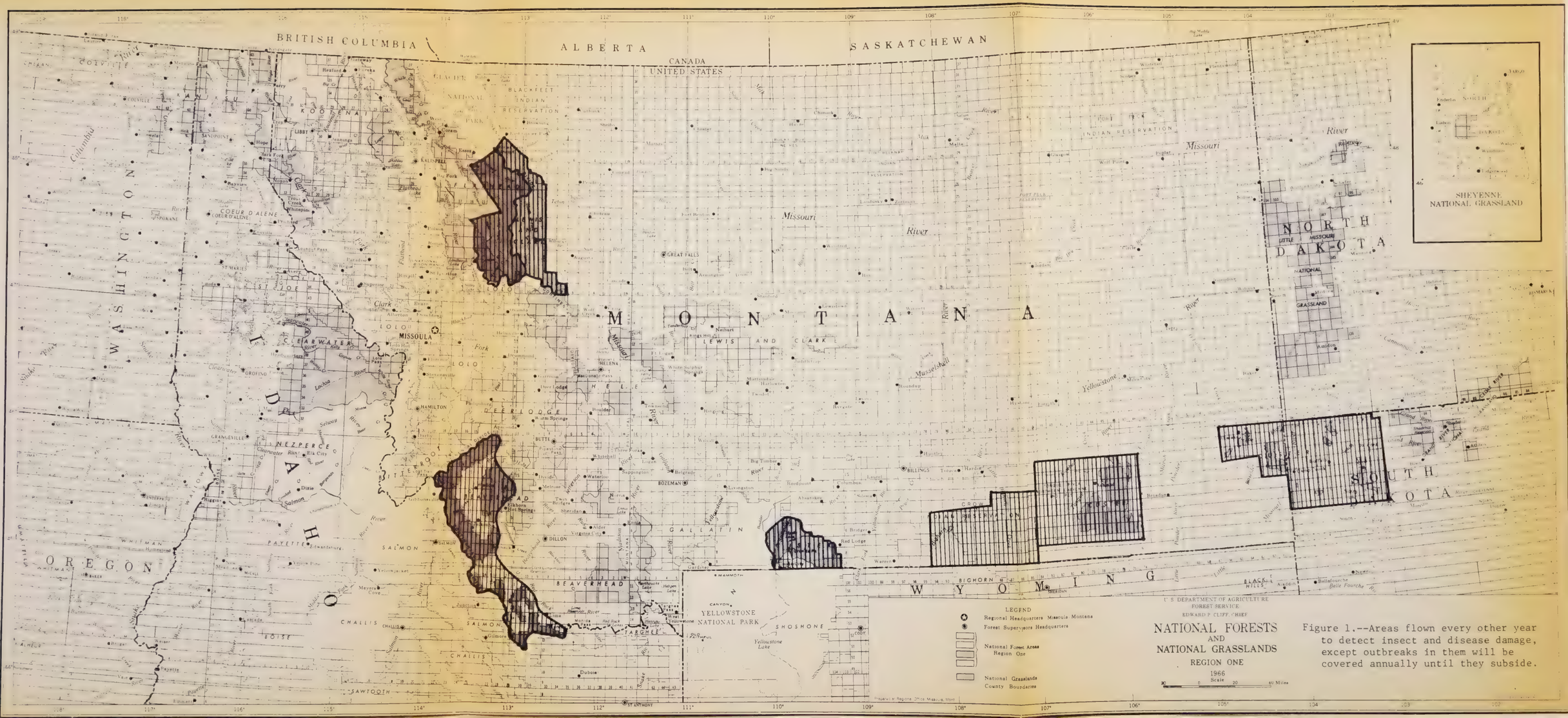

Figure 1.--Areas flown every other year to detect insect and disease damage, except outbreaks in them will be covered annually until they subside.

[redacted]

7. "If the position report is not received, the Forest dispatcher will attempt to contact the plane. After failure to contact the aircraft during the time interval of two consecutive position reports, the Forest will initiate a search after notification of the home base."

8. "The pilot should monitor the Regional air net radio at all times."

AREAS SURVEYED

Not all of the 35 million acres of timbered land in the Northern Region are surveyed each season. Figure 2 shows areas flown every other year. The nonhashmarked portions of forested land on Figure 2 are flown each year. The hashmarked areas in Figure 3 of North Dakota are flown each year. Larch casebearer defoliation in Montana and Idaho will be flown every other year.

Table 3 shows the acres of forested land surveyed in each ownership over the Region.

Aerial survey costs in 1977--In 1977 we flew 7.8 million acres in June to detect larch casebearer defoliation in Montana and Idaho. About 250,000 acres were surveyed in North Dakota for hardwood defoliators, and from mid-July to September, 26.1 million acres were surveyed for other insects and diseases in Montana and Idaho. This totals 34.15 million acres covered by aerial detection surveys in 1977.

Plane costs include $25 per overnight; $8 per hour standby; and $55 per hour flight time. We flew 387.46 hours during the 1977 survey season. Total costs were $26,904, or $69.44 per flight hour, or $0.07 per acre.

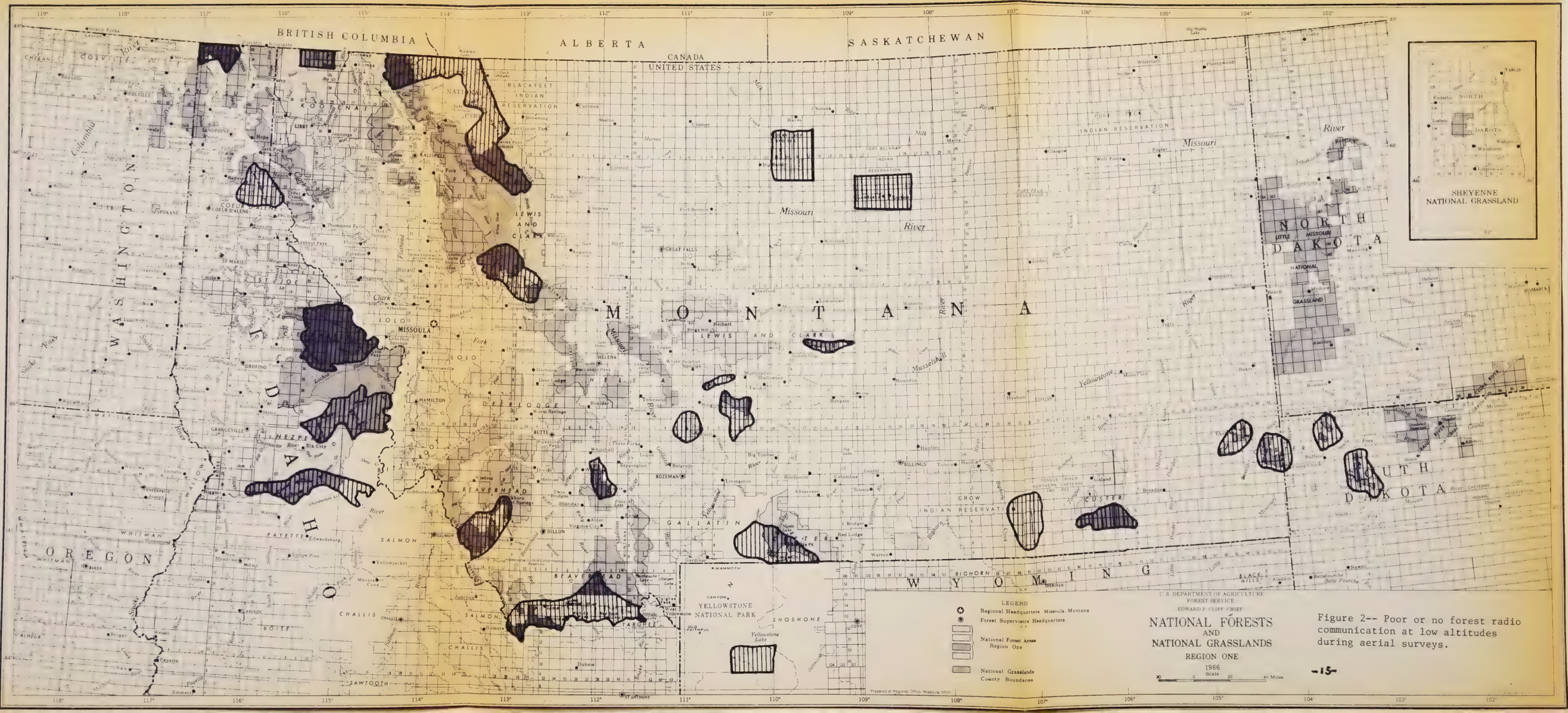

Figure 2-- Poor or no forest radio communication at low altitudes during aerial surveys.

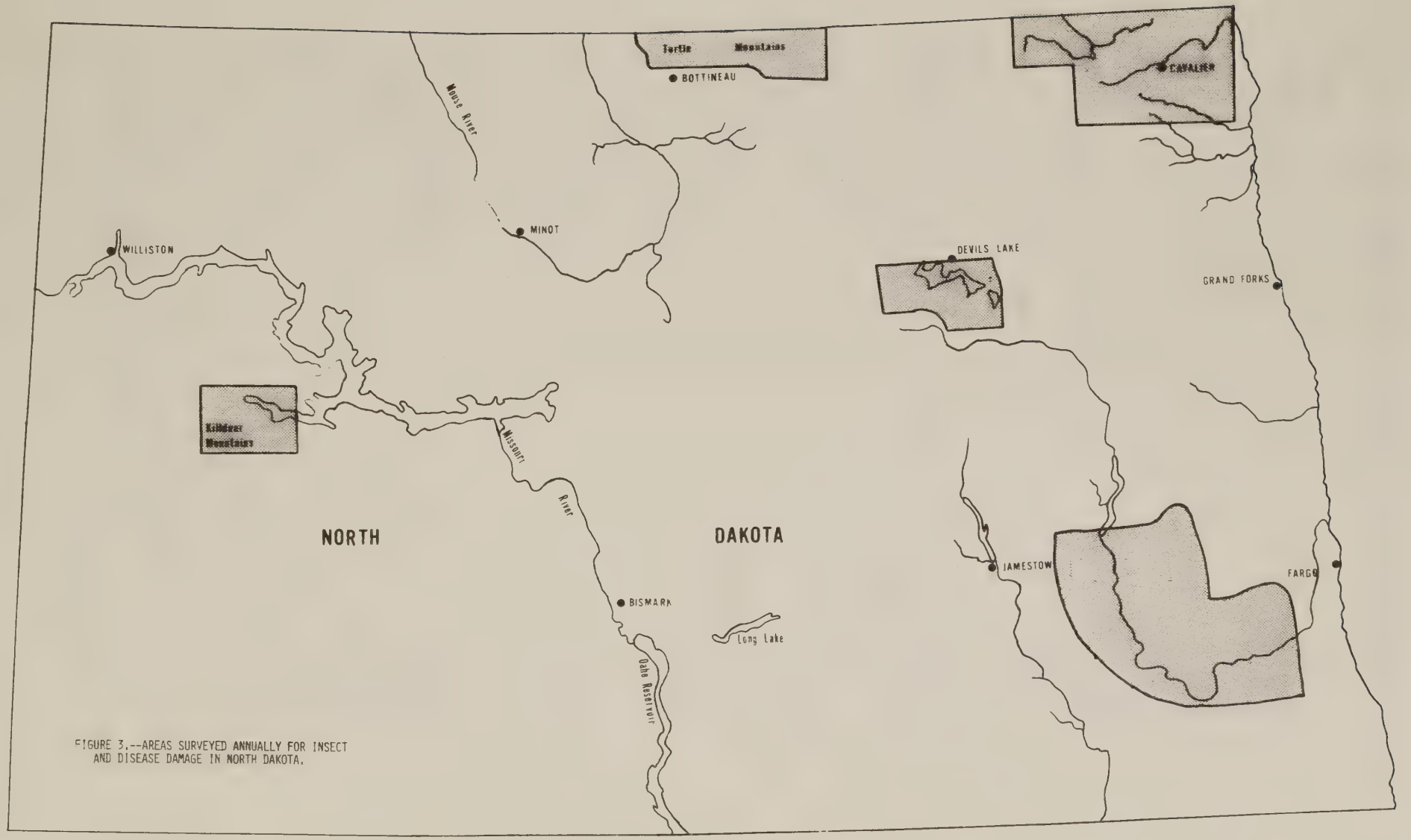

FIGURE 3.--AREAS SURVEYED ANNUALLY FOR INSECT AND DISEASE DAMAGE IN NORTH DAKOTA.

Table 4 --Acres of forested land surveyed for forest pest damage in the Northern Region on all ownerships 1/

MONTANA

National Forests	Acres forested
Beaverhead	1,540,600
Bitterroot (Montana portion)	997,416
Custer	534,600
Deerlodge	976,300
Flathead	2,182,700
Gallatin	1,255,800
Helena	835,200
Kootenai	1,736,831
Lewis and Clark	1,569,300
Lolo	1,940,100
Subtotal	13,568,847
BLM	
Butte District (Missoula & Dillon Zones)	688,922
Lewistown and Miles City Districts	720,448
Subtotal	1,409,370
Indian Reservations	
Blackfeet	119,238
Flathead	448,522
Rocky Boy's	17,105
Fort Belknap	26,831
Crow	107,612
Northern Cheyenne	129,808
Subtotal	849,116
Other Federal	
Glacier National Park	670,512
National Bison Range	2,600
Subtotal	673,112
Private	
Burlington Northern	750,000
Champion Timberlands	600,000
St. Regis	200,000
Others	3,447,000
Subtotal	4,997,000
State	500,000
TOTAL	21,997,445

1/ This information was obtained from letters and telephone calls to landowners and from reports.

Table 4 --Acres of forested land surveyed for forest pest damage in the Northern Region on all ownerships (con.)

NORTHERN IDAHO

National Forests	Acres forested
Bitterroot (Idaho portion)	456,184
Clearwater	1,653,300
Coeur d'Alene	712,100
Kaniksu	1,551,442
Nezperce	1,994,800
St. Joe	861,400
Subtotal	7,229,226
BLM	
Coeur d'Alene District	259,200
Indian Reservations	
Coeur d'Alene and Nezperce	47,857
Corps of Engineers (N. Fk. Clearwater Res.)	36,000
Private	
Potlatch Forests	480,000
Diamond International	143,677
Burlington Northern	170,000
Pack River	100,000
Others	1,651,323
Subtotal	2,545,000
State	674,201
TOTAL	10,791,484

NORTH DAKOTA

BLM	
Dickinson District	1,000
Indian Reservations	
Fort Berthold	1,000
Fort Totten	6,000
Turtle Mountains	40,000
Subtotal	47,000
Other Federal	
Sully's Hill National Game Preserve	1,200
Private	296,000
State	10,000
TOTAL	355,000

WYOMING

Yellowstone National Park	1,801,867
GRAND TOTAL	34,945,996

Table 4 --Acres of forested land surveyed for forest pest damage in the Northern Region on all ownerships (con.)

SUMMARY

OWNERSHIP	Total acres forested
National Forests	20,798,073
BLM	1,669,570
Indian Reservations	943,973
National Parks	2,472,379
Other Federal	39,800
Private	7,838,000
State	1,184,201
GRAND TOTAL	34,945,996